Unit 1 – Skills and Process in Chemistry Review Questions

2. Solve the following using the method of unit conversions.

   a) If there are 6.02×10^{23} atoms in 1 mol of atoms, how many atoms are there in 5.5 mol of atoms?

   b) If one mole of a gas has a volume of 22.4 L, how many moles are there in 25.0 L of gas?

   c) If one mole of nitrogen has a mass of 28 g, how many moles of nitrogen gas are in 7.0 g of nitrogen gas?

   d) How many seconds must an electrical current of 35 coulombs/s flow in order to deliver 200.0 coulombs?

   e) A quiet sound exerts a pressure of 4×10^{-8} kPa ("kPa" = kilopascals, an SI pressure unit). What is this pressure in atmospheres if 1 atmosphere is 101.3 kPa?

   f) A large nugget of naturally occurring silver metal has a mass of 3.20×10^{4} troy ounces. What is the mass in kilograms if 1 troy ounce is equivalent to 0.0311 kg?

3. An old barometer hanging on the wall of a mountain hut has a reading of 27.0 inches of mercury. If 1 inch of mercury equals 0.0334 atm ("atmospheres") and 1 atm = 101.3 kPa ("kilopascals"), what is the pressure reading of the barometer, in kilopascals?

4. It requires 334 kJ of heat to melt 1 kg of ice.

   (a) The largest known iceberg had a volume of about 3.1×10^{13} m^3. How much heat was required to melt the iceberg if 1 m^3 of ice has a mass of 917 kg?

   (b) The explosive "TNT" releases 1.51×10^{4} kJ of energy for every kilogram of TNT which explodes. Provided that all the energy of an explosion went into melting the ice, how many kilograms of TNT would be needed to melt the iceberg in part (a) of this question?

5. Sugar costs \$0.980/kg. 1 t = 1000 kg. How many tonnes ("t") of sugar can you buy for \$350?

6. The Cullinan diamond, the largest diamond ever found, had an uncut volume of 177 mL. If 1 mL of diamond has a mass of 3.51 g and 1 carat = 0.200 g, how many carats was the Cullinan diamond?

17. Convert the following

   (a) 3 s into milliseconds
   (b) 50.0 mL into litres
   (c) 2 L into microlitres
   (d) 25 kg into grams
   (e) 3 Mm into metres
   (f) 2 L into decilitres
   (g) 7 μs into milliseconds
   (h) 51 kg into milligrams
   (i) 3125 μL into kilolitres
   (j) 1.7 μg into centigrams
   (k) 1 year into seconds
   (l) 1 mg/dL into grams per litre
   (m) 1 cm/μs into kilometres/second
   (n) 1 cg/mL into decigrams/litre
   (o) 5 cg/ds into milligrams/second

18. Light travels at a rate of 3.00×10^8 m/s.

(a) It takes light 8.3 min to travel from the surface of the sun to the earth. What is the distance of the earth from the sun?

(b) The moon is 3.8×10^5 km from the earth. What time will pass between the instant an astronaut on the moon speaks and the instant his voice is heard on earth? (His voice travels by modulated laser beam at the speed of light.)

(c) A robot vehicle is travelling on the surface of Mars while Mars and Earth are at their closest approach (7.83×10^7 km). Suddenly, a video camera on the robot shows a yawning crevasse dead ahead! How many minutes will it take for an electronic signal travelling at the speed of light to go from Earth to Mars in order to tell the robot to stop immediately?

19. (Care: Nasty!) A measurement is given as 9.0 lb/in^3. If 1 kg = 2.2 lb and 1 m = 39 in, convert the measurement into kg/m^3.

31. A 3.50 mL chunk of boron has a mass of 8.19 g. What is the density of the boron?

32. An iron bar has a mass of 125 g. If iron's density is 7.86×10^3 g/L, what volume does the bar occupy ?

33. A block of beeswax has a volume of 200.0 mL and a density of 961 g/L. What is the mass of the block?

34. Alcohol has a density of 789 g/L. What volume of alcohol is required in order to have 46 g of alcohol?

35. A gas called neon is contained in a glass bulb having a volume of 22.4 L. If the density of the neon is 0.900 g/L, what is the mass of the neon in the bulb?

36. A 70.0 g sphere of manganese (density = 7.20×10^3 g/L) is dropped into a graduated cylinder containing 54.0 mL of water. What will be the water level indicated after the sphere is inserted?

37. A 25.0 mL portion of each of W, X, Y and Z is poured into a 100 mL graduated cylinder. Each of the 4 compounds is a liquid and will not dissolve in the others. If 55.0 mL of W have a mass of 107.3 g, 12.0 mL of X have a mass of 51.8 g, 42.5 mL of Y have a mass of 46.8 g and 115.0 mL of Z have a mass of 74.8 g, list the layers in the cylinder from top to bottom.

42. How many significant figures do each of the following measurements have?

(a) 1.25 kg
(b) 1255 kg
(c) 11 s
(d) 150 m
(e) 1.283 cm
(f) 365.249 days
(g) 2 000 000 years
(h) 17.25 L

43. Assume you have a balance which gives very precise measurements. What might be true about the balance in order that its readings would be precise but not accurate?

44. A "calibration weight" has a mass of exactly 1.000 000 g. A student uses 4 different balances to check the mass of the weight. The results of the weighings are shown below.

mass using balance A = 0.999 999 g
mass using balance B = 1.00 g
mass using balance C = 3.0 g
mass using balance D = 0.811 592 g

(a) Which of the balances give accurate weighings?
(b) Which of the balances give precise weighings?
(c) Which balance is both accurate and precise?

45. An atomic clock is used to measure a time interval of 121.315 591 s. Assume you have to measure the same time interval. Give an example of a time interval you might actually measure if your measurement is:

(a) not accurate, but is precise.
(b) not precise, but is accurate.
(c) both inaccurate and imprecise.
(d) both accurate and precise.

55. State the number of significant figures in each of the following.

(a) 3570 (b) 17.505 (c) 41.400 (d) 0.51 (e) 0.000 572 (f) 0.009 00 (g) 41.50×10^{-4} (h) $0.007\ 160 \times 10^{5}$ (i) $1.234\ 00 \times 10^{8}$ (j) $0.000\ 410\ 0 \times 10^{7}$

56. Perform the indicated operations and give the answer to the correct number of significant figures.

(a) 12.5×0.50
(b) 0.15×0.0016
(c) $40.0 / 30.0000$
(d) $2.5 \times 7.500 / 0.150$
(e) $(6.40 \times 10^{8}) \times (5 \times 10^{5})$
(f) $4.37 \times 10^{3} / 0.008\ 560\ 0$
(g) 51.3×3.940
(h) $0.51 \times 10^{-4} / 6 \times 10^{-7}$
(i) 4.75×5
(j) $0.000\ 01 / 0.1000$
(k) $7.4 / 3$
(l) $0.000\ 43 \times 0.005\ 001$

57. Perform the indicated operations and give the answer to the correct number of significant figures.

(a) $15.1 + 75.32$
(b) $178.904\ 56 - 125.8055$
(c) $4.55 \times 10^{-5} + 3.1 \times 10^{-5}$
(d) $0.000\ 159 + 4.0074$
(e) $1.805 \times 10^{4} + 5.89 \times 10^{2}$
(f) $0.000\ 048\ 1 - 0.000\ 817$
(g) $7.819 \times 10^{5} - 8.166 \times 10^{4}$
(h) $45.128 + 8.501\ 87 - 89.18$
(i) $0.0589 \times 10^{-6} + 7.785 \times 10^{-8}$
(j) $89.75 \times 10^{-12} + 6.1157 \times 10^{-9}$

58. Perform the indicated operations and give the answer to the correct number of significant figures.

(a) $7.95 + 0.583$
(b) $1.99 / 3.1$
(c) $4.15 + 1.582 + 0.0588 - 35.5$
(d) $1200.0 / 3.0$
(e) $5.31 \times 10^{-4} / 3.187 \times 10^{-8}$
(f) $45.9 - 15.0025$
(g) 375.59×1.5
(h) $5.1076 \times 10^{-3} - 1.584 \times 10^{-2} + 2.008 \times 10^{-3}$
(i) $1252.7 - 9.4 \times 10^{2}$
(j) $0.024\ 00 / 6.000$

59. In the following mixed calculations perform multiplications and divisions before doing the additions and subtractions. Keep track of the number of significant figures at each stage of a calculation.

(a) $25.00 \times 0.1000 - 15.87 \times 0.1036$
(b) $35.0 \times 1.525 + 50.0 \times 0.975$
(c) $(0.865 - 0.800) \times (1.593 + 9.04)$
(d) $\dfrac{(0.3812 + 0.4176)}{(0.0159 - 0.0146)}$
(e) $\dfrac{3.65}{0.3354} - \dfrac{6.14}{0.1766}$
(f) $\dfrac{5.3 \times 0.1056}{0.1036 - 0.0978}$
(g) $(0.341 \times 18.64 - 6.00) \times 3.176$
(h) $9.34 \times 0.071\ 46 - 6.88 \times 0.081\ 15$

ANSWER KEY

2. (a) $\# \text{ of atoms} = 5.5 \text{ mol} \times \frac{6.02 \times 10^{23} \text{ atoms}}{1 \text{ mol}} = \mathbf{3.3 \times 10^{24} \text{ atoms}}$

(b) $\# \text{ of moles} = 25.0 \text{ L} \times \frac{1 \text{ mol}}{22.4 \text{ L}} = \mathbf{1.12 \text{ mol}}$

(c) $\# \text{ of moles} = 7.0 \text{ g} \times \frac{1 \text{ mol}}{28 \text{ g}} = \mathbf{0.25 \text{ mol}}$

(d) $\# \text{ of seconds} = 200.0 \text{ coulombs} \times \frac{1 \text{ s}}{35 \text{ coulombs}} = \mathbf{5.7 \text{ s}}$

(e) $\# \text{ of atmospheres} = 4 \times 10^{-8} \text{ kPa} \times \frac{1 \text{ atm}}{101.3 \text{ kPa}} = \mathbf{4 \times 10^{-10} \text{ atmospheres}}$

(f) $\# \text{ of kilograms} = 3.20 \times 10^{4} \text{ troy ounce} \times \frac{0.0311 \text{ kg}}{1 \text{ troy ounce}} = \mathbf{995 \text{ kg}}$

(g) $\# \text{ of milliseconds} = 5.0 \times 10^{-4} \text{ s} \times \frac{1 \text{ ms}}{10^{-3} \text{ s}} = \mathbf{0.50 \text{ ms}}$

(h) $\# \text{ of moles} = 15\,100 \text{ kJ} \times \frac{1 \text{ mol}}{5450 \text{ kJ}} = \mathbf{2.77 \text{ mol}}$

(i) $\# \text{ of millimetres} = 0.05 \text{ micron} \times \frac{10^{-3} \text{ mm}}{1 \text{ micron}} = \mathbf{5 \times 10^{-5} \text{ mm}}$

(j) $\# \text{ of litres} = 0.0358 \text{ mol} \times \frac{1 \text{ L}}{11.7 \text{ mol}} = \mathbf{0.00306 \text{ L}}$

3. $\# \text{ of kilopascals} = 27.0 \text{ inches} \times \frac{0.0334 \text{ atm}}{1 \text{ inch}} \times \frac{101.3 \text{ kPa}}{1 \text{ atm}} = 91.4 \text{ kPa}$

4. (a) $\text{amount of heat} = 3.1 \times 10^{13} \text{ m}^3 \times \frac{917 \text{ kg}}{1 \text{ m}^3} \times \frac{334 \text{ kJ}}{1 \text{ kg}} = \mathbf{9.5 \times 10^{18} \text{ kJ}}$

(b) $\# \text{ of kilograms} = 9.5 \times 10^{18} \text{ kJ} \times \frac{1 \text{ kg}}{1.51 \times 10^{4} \text{ kJ}} = \mathbf{6.3 \times 10^{14} \text{ kg}}$

5. $\# \text{ of tonnes} = \$350 \times \frac{1 \text{ kg}}{\$0.980} \times \frac{1 \text{ t}}{1000 \text{ kg}} = \mathbf{0.357 \text{ t}}$

6. $\# \text{ of carats} = 177 \text{ mL} \times \frac{3.51 \text{ g}}{1 \text{ mL}} \times \frac{1 \text{ carat}}{0.200 \text{ g}} = \mathbf{3110 \text{ carats}}$

17. (a) $\# \text{ of milliseconds} = 3\text{ s} \times \dfrac{1\text{ ms}}{10^{-3}\text{ s}} = \mathbf{3 \times 10^{3}\ ms}$

(b) $\# \text{ of litres} = 50.0\text{ mL} \times \dfrac{10^{-3}\text{ L}}{1\text{ mL}} = \mathbf{5.0 \times 10^{-2}\ L}$

(c) $\# \text{ of microlitres} = 2\text{ L} \times \dfrac{1\ \mu\text{L}}{10^{-6}\text{ L}} = \mathbf{2 \times 10^{6}\ \mu L}$

(d) $\# \text{ of grams} = 25\text{ kg} \times \dfrac{10^{3}\text{ g}}{1\text{ kg}} = \mathbf{2.5 \times 10^{4}\ g}$

(e) $\# \text{ of metres} = 3\text{ Mm} \times \dfrac{10^{6}\text{ m}}{1\text{ Mm}} = \mathbf{3 \times 10^{6}\ m}$

(f) $\# \text{ of decilitres} = 2\text{ L} \times \dfrac{1\text{ dL}}{10^{-1}\text{ L}} = \mathbf{2 \times 10^{1}\ dL}$

(g) $\# \text{ of milliseconds} = 7\ \mu\text{s} \times \dfrac{10^{-6}\text{ s}}{1\ \mu\text{s}} \times \dfrac{1\text{ ms}}{10^{-3}\text{ s}} = \mathbf{7 \times 10^{-3}\ ms}$

(h) $\# \text{ of milligrams} = 51\text{ kg} \times \dfrac{10^{3}\text{ g}}{1\text{ kg}} \times \dfrac{1\text{ mg}}{10^{-3}\text{ g}} = \mathbf{5.1 \times 10^{7}\ mg}$

(i) $\# \text{ of kilolitres} = 3125\ \mu\text{L} \times \dfrac{10^{-6}\text{ L}}{1\ \mu\text{L}} \times \dfrac{1\text{ kL}}{10^{3}\text{ L}} = \mathbf{3.125 \times 10^{-6}\ kL}$

(j) $\# \text{ of centigrams} = 1.7\ \mu\text{g} \times \dfrac{10^{-6}\text{ g}}{1\ \mu\text{g}} \times \dfrac{1\text{ cg}}{10^{-2}\text{ g}} = \mathbf{1.7 \times 10^{-4}\ cg}$

(k) $\# \text{ of seconds} = 1\text{ yr} \times \dfrac{365\text{ d}}{1\text{ y}} \times \dfrac{24\text{ h}}{1\text{ d}} \times \dfrac{60\text{ min}}{1\text{ h}} \times \dfrac{60\text{ s}}{1\text{ min}} = \mathbf{3.15 \times 10^{7}\ s}$

(l) $\# \text{ of } \dfrac{\text{grams}}{\text{litre}} = \dfrac{1\text{ mg}}{\text{dL}} \times \dfrac{10^{-3}\text{ g}}{1\text{ mg}} \times \dfrac{1\text{ dL}}{10^{-1}\text{ L}} = \mathbf{1 \times 10^{-2}\ \dfrac{g}{L}}$

(m) $\# \text{ of } \dfrac{\text{kilometres}}{\text{second}} = \dfrac{1\text{ cm}}{\mu\text{s}} \times \dfrac{10^{-2}\text{ m}}{1\text{ cm}} \times \dfrac{1\text{ km}}{10^{3}\text{ m}} \times \dfrac{1\ \mu\text{s}}{10^{-6}\text{ s}} = \mathbf{1 \times 10^{1}\ \dfrac{km}{s}}$

(n) $\# \text{ of } \dfrac{\text{decigrams}}{\text{litre}} = \dfrac{1\text{ cg}}{\text{mL}} \times \dfrac{10^{-2}\text{ g}}{1\text{ cg}} \times \dfrac{1\text{ dg}}{10^{-1}\text{ g}} \times \dfrac{1\text{ mL}}{10^{-3}\text{ L}} = \mathbf{1 \times 10^{2}\ \dfrac{dg}{L}}$

(o) $\# \text{ of } \dfrac{\text{mg}}{\text{s}} = \dfrac{5\text{ cg}}{\text{ds}} \times \dfrac{10^{-2}\text{ g}}{\text{cg}} \times \dfrac{1\text{ mg}}{10^{-3}\text{ g}} \times \dfrac{\text{ds}}{10^{-1}\text{ s}} = \mathbf{5 \times 10^{2}\ \dfrac{mg}{s}}$

18. (a) $\# \text{ of metres} = 8.3 \text{ min} \times \frac{60 \text{ s}}{1 \text{ min}} \times \frac{3.00 \times 10^8 \text{ m}}{1 \text{ s}} = \mathbf{1.5 \times 10^{11} \text{ m}}$

(b) $\# \text{ of seconds} = 3.8 \times 10^5 \text{ km} \times \frac{10^3 \text{ m}}{1 \text{ km}} \times \frac{1 \text{ s}}{3.00 \times 10^8 \text{ m}} = \mathbf{1.3 \text{ s}}$

(c) $\# \text{ of minutes} = 7.83 \times 10^7 \text{ km} \times \frac{10^3 \text{ m}}{1 \text{ km}} \times \frac{1 \text{ s}}{3.00 \times 10^8 \text{ m}} \times \frac{1 \text{ min}}{60 \text{ s}} = \mathbf{4.35 \text{ min}}$

19. $\# \text{ of } \frac{\text{kg}}{\text{m}^3} = \frac{9.0 \text{ lb}}{\text{in}^3} \times \frac{1 \text{ kg}}{2.2 \text{ lb}} \times \left(\frac{39 \text{ in}}{1 \text{ m}}\right)^3 = \mathbf{2.4 \times 10^5 \frac{kg}{m^3}}$

31. $d = \frac{m}{V} = \frac{8.19 \text{ g}}{3.50 \text{ mL}} = \mathbf{2.34 \frac{g}{mL}}$, or: $d = \frac{8.19 \text{ g}}{3.50 \times 10^{-3} \text{ L}} = \mathbf{2.34 \times 10^3 \frac{g}{L}}$

32. $V = \frac{m}{d} = \frac{125 \text{ g}}{7.86 \times 10^3 \text{ g/L}} = \mathbf{0.0159 \text{ L}}$

33. $m = d \cdot V = 961 \frac{\text{g}}{\text{L}} \times 0.2000 \text{ L} = \mathbf{192 \text{ g}}$

34. $V = \frac{m}{d} = \frac{46 \text{ g}}{789 \text{ g/L}} = \mathbf{0.058 \text{ L}}$

35. $m = d \cdot V = 0.900 \frac{\text{g}}{\text{L}} \times 22.4 \text{ L} = \mathbf{20.2 \text{ g}}$

36. $V_{SPHERE} = \frac{m}{d} = \frac{70.0 \text{ g}}{7.20 \times 10^3 \text{ g/L}} = 0.00972 \text{ L} = 9.72 \text{ mL}$

$V_{TOTAL} = V_{SPHERE} + V_{START} = 9.72 + 54.0 = \mathbf{63.7 \text{ mL}}$

37. Since less dense liquids float on more dense liquids, the least dense layer will be at the top and the most dense layer will be at the bottom, as shown below. The order is: Z, Y, W and X on the bottom.

$d_Z = \frac{m}{V} = \frac{74.8 \text{ g}}{115.0 \text{ mL}} = 0.650 \frac{\text{g}}{\text{mL}}$ $\qquad d_W = \frac{m}{V} = \frac{107.3 \text{ g}}{55.0 \text{ mL}} = 1.95 \frac{\text{g}}{\text{mL}}$

$d_Y = \frac{m}{V} = \frac{46.8 \text{ g}}{42.5 \text{ mL}} = 1.10 \frac{\text{g}}{\text{mL}}$ $\qquad d_X = \frac{m}{V} = \frac{51.8 \text{ g}}{12.0 \text{ mL}} = 4.32 \frac{\text{g}}{\text{mL}}$

42. (a) 3 (b) 4 (c) 2 (d) 2 (e) 4 (f) 6 (g) 1 (h) 4

43. The balanced has been damaged or mis–calibrated in such a way that all the readings are a few grams too high or too low, for example.

44. (a) A, B (b) A, D (c) A

45. (a) A time reading with lots of digits, most of which are incorrect; for example: 75.987 654 s
(b) A time reading with few digits, but the digits are close to the correct time; for example: 121.3 s
(c) A time reading with few digits, most of which are incorrect; for example: 88 s
(d) A time reading with lots of digits, and a value which is quite close to the accepted value; for example: 121.315 593 s

55. (a) 3 (b) 5 (c) 5 (d) 2 (e) 3 (f) 3 (g) 4 (h) 4 (i) 6 (j) 4

56. (a) 6.3 (b) 0.000 24 (c) 1.33 (d) 1.3×10^2 (e) 3×10^{14} (f) 5.11×10^5 (g) 202 (h) 90 (i) 20 (j) 1×10^{-4} (k) 2 (l) 2.2×10^{-6}

57. (a) 90.4
(b) 53.0991
(c) 7.7×10^{-5}
(d) 4.0076
(e) 1.864×10^4
(f) −0.000 769
(g) 7.002×10^5
(h) −35.55
(i) 0.1368×10^{-6} or 1.368×10^{-7}
(j) 6.2055×10^{-9}

58. (a) 8.53 (b) 0.64 (c) −29.7 (d) 4.0×10^2 (e) 1.67×10^4 (f) 30.9 (g) 5.6×10^2 (h) -8.72×10^{-3} (i) 3.1×10^2 (j) 0.004 000

59. (a) 0.856 (b) 102.1 (c) 0.69 (d) 610 (e) −23.9 (f) 96 (g) 1.1 (h) 0.109